2.3 Aircraft Safety Program Area Description

Mission

The mission of the Aircraft Safety program is to provide a safe global air transportation system by establishing safety standards and acceptable practices through development of technical information, tools, and technology to ensure safe operation of the civil aircraft fleet.

This program addresses the many hazards that face all aircraft in flight, as well as special hazards that apply to select portions of the civil aircraft fleet. For example, older aircraft are more susceptible to structural problems associated with fatigue and corrosion. New aircraft—with their digital flight control and avionics systems, associated embedded software, and construction of new non-metallic materials—present significant challenges in certification, continued airworthiness, and operation. However, all aircraft, old or new, must deal with the hazards of adverse weather.

Intended Outcomes

The Aircraft Safety program supports the FAA's safety mission goal, "by 2007, reduce U.S. aviation fatal accident rates by 80 percent from 1996 levels."

The Aircraft Safety program focuses on improving system safety through the following research programs:

- *Support aging aircraft* by developing technologies, procedures, and practices that ensure the continued airworthiness of aircraft structures and aircraft mechanical and electrical systems in the civil fleet.
- *Prevent catastrophic failure* by developing technologies and methods that will assess the risk and prevent defects, failures, and malfunctions of aircraft, aircraft components, and aircraft systems that could result in catastrophic failure of the aircraft.
- *Promote flight safety and reduce the effects of atmospheric hazards* by addressing atmospheric hazards in the design, development, and certification process.
- *Improve propulsion and fuel systems* by enhancing the airworthiness, reliability, and performance of civil turbine and piston engines, their propellers, fuels, and fuel management systems.
- *Support fire research and safety* by developing near-term fire safety improvements to prevent uncontrollable in-flight fires and increase post-crash fire survival rates and conduct long-range research to develop ultra fire-resistant cabin materials.
- *Promote advanced materials and structural safety* by ensuring both the safety of U.S. civil aircraft constructed of advanced materials and passenger survival in the event of an accident.
- *Introduce a new disk design and life management computer tool*, "Design Assessment of Reliability with Inspection," with potential to allow engine manufacturers to reduce the disk failure rate in turbine-powered engines. Use of the new tool will provide a further measure of safety by allowing disk designers to assume the potential presence of tiny flaws in the design life determinations. This new method also will give insight into planning the most effective inspection program. The technology is the result of a four-year FAA-funded research project conducted in collaboration with engine manufacturers AlliedSignal, Rolls Royce-Allison, General Electric, and Pratt & Whitney.
- *Develop an aircraft mounted wide area ice detection system* to reduce icing accidents. A hand-held system will allow the inspector to work more conveniently, quickly, and accurately in detecting ice on critical surfaces. Unnecessary use of environmentally harmful deicing fluids will be eliminated, airlines will save time, and travelers will save money.

Aircraft safety improvements will reduce fatalities and injuries, reduce hull losses, improve aircraft designs, and impact maintenance and inspection procedures. Potential significant safety benefits include:

- Reduction of the approximately 30 to 35 U.S. fire fatalities per year and 135 worldwide, in otherwise survivable accidents.
- Use of a more reliable airframe inspection technique that has been approved as an alter-

nate inspection technique for detecting corrosion at the juncture of wing and fuselage on DC-9's. The new technique will save over 700 person-hours per inspection, compared to the current inspection method. The technique also requires less disassembly of the aircraft part to conduct the inspection, resulting in less chance for damage during disassembly and reassembly. One airline estimates that by using the new inspection technique, it can save over $2 million over the maintenance cycle for its fleet of DC-9s.

Program Area Outputs

The FAA establishes rules for aircraft certification, operation, inspection, maintenance and repair, and publishes advisory circulars to outline acceptable means of meeting the rules. The agency also disseminates technical information in various forms to its airworthiness inspectors and to industry to improve aircraft construction and maintenance practices. Technical information is developed to establish criteria for safety systems, such as seat restraints and protective breathing equipment. The primary objective is to improve system safety based on elimination of causal factors related to aircraft and flight hazards. Aircraft safety research provides the technical information necessary to support agency outputs.

Aircraft Safety program research customers include aviation manufacturers and aircraft and avionics maintenance facilities, aircraft operators, and the general public who use commercial air transportation. The safety research program supports customer requirements by providing tools that enable demonstration of compliance and development of advisory information to ensure the safety of the flying public. Aviation safety research sponsors are FAA personnel in Flight Standards (AFS) and Aircraft Certification (AIR). The aircraft safety program supports sponsor requirements by providing the research to aid rulemaking and regulation development and by developing technical data and guidance material to develop standards, rules, and regulations.

Program Area Structure

The Aircraft Safety program includes research in a wide range of areas related to aircraft and passenger safety. It focuses on eliminating hazards to the air transportation system, by both preventing accidents from happening and mitigating the effects of those accidents that do occur. Prevention and mitigation activities include:

- *Accident and incident prevention*
  - – Structural integrity (preventing aircraft structural failure)
  - – Propulsion systems (ensuring reliable aircraft power)
  - – Flight safety (minimizing operational hazards)
  - – Mechanical and electrical system reliability and integrity (reducing aircraft systems failure)
- *Accident and incident mitigation*
  - – Crashworthiness (maximizing crash survivability and escape)
  - – Fire safety (preventing fire and fire fatalities)

Customer and Stakeholder Involvement

Research programs within the Aircraft Safety program directly support the Aviation Safety Plan (February 1996) through research supporting priority issues associated with the following workshops: "Safety Data Collection and Use," "Application of Emerging Technologies," and "Aircraft Maintenance Procedures and Inspection."

The Subcommittee on Aircraft Safety, of the FAA Research, Engineering, and Development Advisory Committee, periodically reviews the Aircraft Safety program area. The most recent review was completed in 2000. The program described here is fully responsive to the advice of the subcommittee.

The FAA's primary mission, as originally mandated in Sections 312 and 316 of the Federal Aviation Act of 1958, is to develop, modify, test, and evaluate systems, procedures, facilities, and devices to meet the needs of safe and efficient aviation. The FAA's research mission was expanded when Congress passed the legislation known as the Aviation Safety Research Act of 1988 (Public Law 100-591). This act mandates that the FAA: "Undertake or supervise research to develop technologies and to conduct data analysis for predicting the effects of aircraft design, maintenance, testing, wear, and fatigue on the life of aircraft

and on air safety, to develop methods of analyzing and improving aircraft maintenance technology and practices." The act also authorized the FAA to generate technology breakthroughs where technology gaps need to be closed while emphasizing the importance of long-range research.

Passage of the Aircraft Catastrophic Failure Prevention program under the Omnibus Reconciliation Act of 1990 (Public Law 101-508) further expanded the FAA research mission. While the FAA mission originally focused on airplane improvements, the 1990 amendment added proactive research to make airplanes safe from catastrophic failure.

In 1998 the FAA published the Aging Transport Nonstructural Systems Plan in response to the Gore Commission's recommendation. Research is being developed as recommended in that plan.

Safety research will reduce the hazards of operating aircraft, thus providing a higher level of safety. Much of the technology developed will also enhance U.S. aviation industry competitiveness for both manufacturers and operators.

Accomplishments

Research results are disseminated to the agency (aircraft certification and flight standards) and to industry (aircraft manufacturers, operators, and maintainers) as:

- Technical and regulatory guidance for airframe maintenance in the form of handbooks, technical bulletins, aircraft-specific inspection requirements, advisory circulars, and rules.
- Validated instrumentation, procedures, and methodologies for aircraft maintenance, inspection, and repair.
- Reports that provide relevant technical information for aircraft manufacturers, operators, and maintainers.
- Technical data provided to the community at conferences, symposia, workshops, and hardware/software prototype demonstrations.
- Criteria to support certification of aircraft and their safety and emergency equipment.
- Technical data to support regulatory oversight in inspection, maintenance, repair, and standards development.
- Training materials in areas such as damage tolerance requirements, corrosion control, inspection, and maintenance and repair.

Several prototype inspection devices developed, tested, and validated in this research program have shown significant potential for more accurate, reliable flaw detection in the airframe and in engines. One method for engine component inspection in particular has shown a dramatic improvement in sensitivity for detecting the type of flaw that led to the 1989 Sioux City accident that killed 211 people.

A large number of advisory circulars (AC) have been developed for a wide range of aviation safety-related activities, including design of composite structures, corrosion control, aircraft deicing, inspection, and repair. ACs controlling aircraft ground deicing for both large transport airplanes (AC 120-58, 9/92) and smaller commuter airplanes (AC 135-17, 12/94) are aimed at ensuring the safe operation of large airplanes and air taxis during icing conditions. These ACs provide guidelines for developing adequate deicing procedures.

R&D Partnerships

Program activities are closely coordinated with related initiatives underway within other government agencies, including the Department of Energy (DOE), DOD, and NASA. Formal agreements of cooperation are in place with the Air Force, Army, Navy, NASA, DOE, and in developing standardization data for materials in Military Handbooks 5 and 17.

International agreements are in place with government agencies and research laboratories in the

United Kingdom, The Netherlands, France, Italy, Australia, Canada, and Russia and the Peoples Republic of China.

Numerous grants are in place with universities and research laboratories to leverage their interests and capabilities. Partnerships have been established with academia and industry through consortia and centers of excellence. For example, the Airworthiness Assurance Center of Excellence (AA-COE) was established in September 1997 to conduct research in the areas of:

- Maintenance, inspection, and repair

- Crashworthiness
- Propulsions and fuel systems safety technologies
- Advanced materials

The AA-COE consists of nine core members, 90 industry partners, 45 university affiliates, and seven other partners, including other Government laboratories and state organizations. The COE provides matching funds, which solidify a significant COE-FAA partnership. Through this partnership, the Government, academic institutions, and industry leverage the resources available for aviation research.

Technology transfer will occur through a variety of mechanisms, including:

- Technical reports documenting research results.
- Conferences on a wide range of subjects designed to disseminate technical information.
- Technical organizations, such as the American Society on Testing and Materials (ASTM), Society of Automotive Engineers (SAE), and American Institute of Aeronautics and Astronautics (AIAA), that use study committees to ensure the transition of research results to standards, guidelines, etc.
- Hardware and software prototype demonstrations and technology workshops.
- The FAA Airworthiness Assurance Nondestructive Inspection Validation Center (AANC) demonstrations and validations of cost-effective aircraft inspection equipment and techniques to industry.

Long-Range View

As air traffic continues to increase, and as aircraft continue to age, the need for safety and safety-related research will continue indefinitely. Research in aircraft safety must be continued to understand the full impact of changes in technology on current regulatory safety standards, certification procedures, and acceptable practices.

A06a Fire Research and Safety

GOALS:

Intended Outcomes: The FAA intends to improve system safety by developing technologies, procedures, test methods, and criteria for preventing accidents caused by in-flight fires and fuel tank explosions and eliminating burning cabin materials as a factor in post-crash fire survivability. The fire research and safety program focuses principally on:

- Long-term research to develop new interior materials that meet fire resistance criteria mandated in the Aviation Safety Research Act of 1988.
- Near-term improvements in aircraft fuel tank explosion protection, fire detection and suppression systems and interior materials fire test methods and criteria.

Agency Outputs: The FAA establishes rules for aircraft fire safety in terms of material selection, design criteria, and operational procedures. The agency also provides advisory material on methods of compliance with fire safety regulations and guidelines. The fire research and safety program is the major source of technical information used to develop this regulatory material. Additionally, the program provides industry with new safety products developed through long-term applied research. These products are typically embodied in new materials and formulations, new test methods, government-owned patents, reports, and journal publications.

Customer/Stakeholder Involvement: The FAA has broad industry and government participation in each aspect of the fire research and safety program.

- The Aircraft Safety Subcommittee of the FAA Research, Engineering and Development Advisory Committee has repeatedly endorsed the fire research and safety program and placed high priority on its activities.
- Long-term research in fire resistant materials is required by specific language in the Aviation Safety Research Act of 1988 and is directly supported by the aircraft industry and materials producers through university-based FAA research consortia.
- The FAA created an Aviation Rulemaking Advisory Committee (ARAC) on fuel tank inerting to recommend viable methods of fuel tank protection. This industry working group will be supported by the FAA and will impact related research.
- The aircraft manufacturers and airlines have a need to improve fire detection and suppression systems and interior material fire tests. Recognizing the FAA's unique capabilities in fire safety, the aviation industry actively participates in systems fire protection and material fire tests working groups headed by the FAA. Foreign airworthiness authorities are active participants, as well, to ensure harmonization of outputs.
- The National Transportation Safety Board (NTSB) relies heavily on program personnel for on-site accident investigation and related testing.

Accomplishments: Results of fire research and safety were provided to FAA certification and inspection personnel for use in fire safety regulations and advisory material, approval of regulatory fire test procedures, and approval of aircraft fire protection installations. Recent program accomplishments include:

- Developed new, broader and more stringent thermal acoustical insulation fire test criteria that were the basis for a major Airworthiness Directive (AD) adopted on May 26, 2000, requiring insulation blanket replacement in over 700 commercial airliners, and a planned Notice of Planned Rulemaking (NPRM). Published upgraded Aircraft Materials Fire Test Handbook, the most complete description of all required as well as currently available aircraft fire test standards.
- Developed thermal protection criteria for medical oxygen cylinder carrying cases (overpacks) proposed in NPRM issued by the Research and Special Programs Administration (RSPA).
- Developed performance standards for gaseous halon replacement agents used in cargo compartment fire suppression systems and cabin hand-held extinguishers.

- Completed detailed cost analysis of a ground-based inerting system, demonstrating a positive cost/benefit (viability).
- Demonstrated a decorative panel with 60% reduction in heat release rate per FAR 25.853.
- Completed development of commercial prototype microscale heat release rate calorimeter (patent awarded).
- Supported pilot plant production by a major resin supplier of chloral polymers for aircraft interior applications demonstrated by the FAA to have superior fire performance.

In addition, approximately two dozen reports and published papers are generated yearly from the in-house activity. Fire test laboratories are used annually to train FAA certification engineers, and program personnel participate in approximately three major accident investigations yearly at the request of the NTSB. The FAA operates the most extensive aircraft fire test facilities in the world.

R&D Partnerships: The FAA sponsors an international systems fire protection working group. This group collaborates in research and development related to fuel tank protection, fire/smoke detectors and halon replacement. The FAA also sponsors an international aircraft materials fire test working group. This group strives to improve material fire tests standardization, such as engaging in round robin testing to ensure that the lab-to-lab variation in results is acceptably small. FAA and NASA have an integrated program to conduct research on gas generation systems for fuel tank protection and emergency oxygen, advanced fire/smoke detectors and ultra fire resistant materials. The FAA organized an interagency working group on fire and materials to provide a vehicle for technology exchange among U.S. Government agencies and to prevent unwarranted duplication of work. The FAA has an interagency agreement with the National Institute of Standards and Technology (NIST) to research the impressive fire retardant mechanism of nanometer clay particles. The agency has a memorandum of cooperation with the British Civil Aviation Administration (CAA) for a variety of fire safety research efforts and separate letters of cooperation with Canadian, Japanese, and European aviation authorities. The fire research and safety program also has grant programs with many educational institutes. Several Fortune 100 companies share costs of developing new fire resistant materials at university-based FAA research consortia.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Fire Resistant Materials

- Developed user friendly method for predicting material flammability from chemical structure.
- Made available heat release data base for cabin materials on FAA web site.
- Demonstrated elastomers for seat cushions with 50% reduction in heat release rate.

Fire Safety Improvements

- Completed aircraft test article for test, evaluation and development of a fuel tank ground-based inerting system.
- Determined the effect of oxygen concentration and altitude (pressure) on the severity of fuel tank explosions.
- Characterized hollow fiber membrane nitrogen generating system in small-scale fuel tank test article.
- Tested and evaluated a hybrid water spray/nitrogen inerting system for cargo compartment fire suppression effectiveness.
- Determined replacement agents (CF3I and HFC-125) quantities for equivalent performance to halon as specified by engine nacelle minimum performance standard.
- Evaluated aircraft cargo smoke detector response to fire and nuisance alarms.
- Characterized smoldering and flaming cargo fire sources for development of certification standards for cargo smoke detectors.
- Designated and constructed a full-scale fuselage test article for characterizing fire hazards in new double-decked Very Large Transport Aircraft (VLTA).

KEY FY 2002 PRODUCTS AND MILESTONES:

Fire Resistant Materials

- Demonstrate fiber for seat upholstery, carpet, drapes and decorative murals with 50% reduction in heat release rate.
- Scale-up and formulate ultra-fire resistance plastics for aircraft applications.
- Conduct physical, chemical and flammability tests on scaled-up plastic specimens.

Fire Safety and Improvement

- Design, fabricate and install an airborne ground-based inerting system in aircraft test article.
- Determine applicability of an on-board ground-based fuel tank inerting system to replace or supplement cargo compartment and other fire suppression systems and the associated weight savings.
- Draft a revised Advisory Circular (AC) for approval testing of cargo smoke detectors.
- Validate mathematical model to predict the transport of in-flight fire products throughout a cargo compartment.
- Characterize VLTA cabin fires under full-scale fire test conditions.

FY 2002 PROGRAM REQUEST:

In FY 2002, the superior fire performance of a fiber for seat upholstery and carpet will be demonstrated. With the completion of this milestone, promising polymers for all four major interior material categories (resins, plastics, elastomers and fibers) will have been identified with demonstrated low heat release performance. In FY 2002, ultra fire resistance plastics will be formulated and scaled up for aircraft applications. Physical, chemical and flammability tests will also be conducted on the scaled-up specimens. Based on the measured performance, serviceable aircraft materials will be down selected in FY 2003 with comparable life cycle costs to current materials.

In FY 2002, research on fuel tank protection will focus primarily on the development and evaluation of a ground-based inerting (GBI) system. Recent FAA cost analysis, computer modeling and small-scale experimental findings indicate that GBI is the most cost effective and practical approach for fuel tank flammability protection. In FY 2002, an airborne GBI system will be designed, fabricated and installed in an airplane, and will be tested and evaluated in FY 2003. A study will also be conducted to determine if and how nitrogen supplied by a GBI system will meet the performance requirements of required or optional fire suppression systems, and the assorted weight savings.

In FY 2002, a mathematical model to predict the transport of in-flight fire products throughout a cargo compartment will be validated. The model capabilities and other research findings will be used in a revised advisory circular that will be completed in FY 2002. The AC will specify standards for the approval of cargo smoke detectors, including advanced designs incorporating multiple sensors and computer algorithms designed to improve detector sensitivity and reduce false alarms. With the launching of the new A3XX mega transport by Airbus becoming a distinct possibility, the need for new fire safety standards for these double decked VLTAs needs to be determined. In FY 2002, VLTA fires will be characterized under full-scale test conditions in order to establish fire safety areas that may require new or enhanced requirements.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 96,076
FY 2001 Enacted	4,740
FY 2002 Request	5,242
Out-Year Planning Levels (FY 2003-2006)	22,636
Total	$ 128,694

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Fire Research and Safety	3,377	2,098	1,292	1,671	2,340
Personnel Costs	3,001	2,315	3,116	2,856	2,621
Other In-house Costs	615	337	342	213	281
Total	**6,993**	**4,750**	**4,750**	**4,740**	**5,242**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	6,993	4,750	4,750	4,740	5,242
Development (includes prototypes)	0	0	0	0	0
Total	**6,993**	**4,750**	**4,750**	**4,740**	**5,242**

A06a - Fire Research and Safety Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
061-110 Fire Research & Safety							
Fire Resistant Materials	$987						
Demonstrated Elastomer for Seat Cushions with 50% Reduction in Heat Release Rate		◆					
Demonstrate Fiber for Seat Upholstery with 50% Reduction in Heat Release Rate			◇				
Scale-Up and Formulate Plastics for Evaluation			◇				
Conduct Physical, Chemical and Flammability Tests on Scaled-Up Specimens			◇				
Down Select Plastics to Serviceable Aircraft Materials				◇			
Identify Low Heat Release Interior Materials with Comparable Life Cycle Costs/Service Performance to Current Materials							◇
Fire Safety Improvements	$1,353						
Designed & Constructed a Full-scale VLTA Fuselage Test Article		◆					
Characterize Cabin & Fuselage Fires in VLTA			◇				
Define VLTA Fire Protection Methodology						◇	
Tested and Evaluated a Hybrid Cargo Compartment Water Spray/Nitrogen Inerting Fire Suppression System		◆					
Determined Effect of Oxygen and Pressure on Severity of Fuel Tank Explosive Hazards		◆					
Complete Aircraft Test Bed for GBI System		◆					
Design and Install an Airborne GBI Fuel Tank Inerting System			◇				
Flight Test GBI Fuel Tank Inerting System					◇		
Recommend Design Criteria for a GBI Fuel Tank Protection System						◇	
Evaluated Cargo Smoke/Fire Detector Response to Fire and Nuisance Alarms		◆					
Characterized Smoldering and Flaming Cargo Fire Sources for Development of Certification Standards for Cargo Smoke Detectors		◆					
Validate Math Model to Predict Transport of Cargo Five Products			◇				
Revise Draft Advisory Circular for Smoke/Fire Detection			◇				
Personnel and Other In-House Costs	$2,902						
Total Budget Authority	$5,242	$4,740	$5,242	$5,404	$5,565	$5,749	$5,919

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A06b Advanced Materials/Structural Safety

GOALS:

Intended Outcomes: The FAA intends to ensure the safety of U.S. and foreign-made civil aircraft constructed of advanced materials as well as to improve passenger survival in the event of an accident. The study of advanced materials focuses on the following technical areas:

- Standardized analysis and test methods for worldwide harmonization.
- Better understanding of effects of repeated loads, damage, and joint configurations and remaining strength and life of composite aircraft structures.
- Reliability methods, as they apply to the design of composite aircraft components, and criteria for acceptable risk.

The study of structural safety focuses on the following technical areas:

- Enhanced occupant survivability and reduced personal injury in the event of an accident.
- Improved crash characteristics of aircraft structures, cabin interiors, auxiliary fuel tank systems, and occupant seat/restraint systems.
- Improved analytical and modeling capabilities to develop understanding of aircraft crash events to lead to more efficient certification.

Agency Outputs: The FAA establishes rules for aircraft certification and operation and publishes Advisory Circulars (AC) to provide acceptable means of achieving compliance with those rules. While the rules are the same for composite or metal structure, the means of compliance reflect behavioral differences in the structural materials. AC 20-107A, "Composite Structure" has been published, but advances in technologies and materials lead to periodic updates and expansion of the AC. Technical information is disseminated to regulatory personnel through technical reports, handbooks, and guidance by the FAA National Resource Specialist. The goal is to develop pertinent data, so that the regulatory processes keep pace with industry advances, including state-of-the-art test and evaluation for state-of-the-art technology and design. The advanced materials/structural safety program provides support in rulemaking and the development of guidance material for industry compliance. In structural safety, the FAA revises or updates Federal Aviation Regulations to accommodate new information for overhead stowage bins, auxiliary fuel tanks, aircraft configurations, and seat/restraint systems.

Customer/Stakeholder Involvement: The FAA has demonstrated the need for the advanced materials/ structural safety program through consensus building activities including:

- The Aviation Rulemaking Advisory Committee (ARAC) is a FAA/industry forum established to ensure that agency rulemaking is effective in achieving intended results. ARAC is also effective in identifying requirements and priorities for supporting R&D activities.
- The Challenge 2000 report concludes that the FAA should enhance its already effective program of gathering data and improving the certification of composite structures.
- A recent National Research Council report highlights the needs related to advanced materials and urges the FAA to step up advanced materials research for aircraft community benefits.
- The 1994 DOT Strategic Plan established Goal 3.3, "support the use of advanced materials in manufacturing and constructing transportation facilities and equipment."
- The advanced materials/structural safety program is responsive to Public Law 100-591, Aviation Safety Research Act of 1988, and House of Representatives Report 100-894, to develop technologies, to conduct data analysis for current aircraft, and to anticipate problems of future aircraft.

Accomplishments: Results of this program are provided to aircraft manufacturers, maintainers, and operators in the form of technical reports, handbooks, ACs, and guidance in the process of certification.

In the advanced materials area, the program has updated or issued two ACs and four handbooks, resulted in an FAA policy memo, published more than 50 technical reports, articles, and papers, and has cosponsored three technical conferences with

attendance of approximately 1,200 experts. A three volume report on test methods for composites was disseminated to industry and government to provide an authoritative compendium on state-of-the-art composites testing with recommendations for usage and identified gaps. One of the gaps was rectified by developing an American Society for Testing and Materials (ASTM) standard for compression testing. An alternative method of compliance to demonstrate repeated load life was developed and now significantly reduces fatigue testing time to ensure required service life. This method has been used successfully in the certification process of many aircraft components (recent example, the General Electric 90 fan blades) and has been adopted as a worldwide practice.

In the structural safety area, six reports on in-house commuter crash testing, as well as reports on aircraft ditching and aircraft flotation, have been widely disseminated. Rulemaking has been proposed for commuter seat/restraint systems. Also, in-service overhead stowage bins have been made more resilient to crash impact. A workshop on a crash impact modeling code developed by the FAA was held for certification engineers and industry participants.

R&D Partnerships: In the advanced materials area, the FAA coordinates with NASA to leverage research expenditures. The FAA concentrates on safety and certification issues, including testing, while NASA has the lead in analysis and design issues. Currently, the FAA supports NASA's efforts to develop a composite property database for General Aviation (GA) aircraft under the NASA Advanced GA Transport Experiments (AGATE)/Integrated Design and Manufacturing (IDM) Program. The FAA has also initiated a partnership with the Rotorcraft Industry Technology Association (RITA) to share in rotorcraft composite materials research.

The FAA cosponsors, with the U.S. Army, MIL-HDBK-17, a primary and authoritative source for statistically-based characterization data of current and emerging composite materials. This international reference reflects the best available data and technology for testing and analysis, and includes data development and usage guidelines. The handbook is used by FAA officials as a primary supporting document in structural substantiation in the certification process. On recommendations by the ARAC material data contained in this handbook will be acceptable for use in the certification process. In the structural safety area, there are agreements for cooperative programs with the National Highway Traffic Safety Administration (NHTSA), with the U.S. Army and Navy, and with NASA Langley Research Center.

There has been coordination with the French and Italian Governments through memoranda of cooperation and an exchange of personnel in the crash testing area. A cooperative research program in the development of crash modeling software tools is underway with the United Kingdom. The program has also worked closely with Wichita State University to develop crash dynamic models and experimental energy absorbing seats.

The structural safety area has established working relationships with airframe manufacturers such as Boeing and Raytheon and with manufacturers of overhead bins and auxiliary fuel tanks. The advanced materials and structural safety areas are benefiting from a close working relationship with the Airworthiness Assurance Center of Excellence. The research performed under this program is leveraged by the monetary and intellectual contributions of its core universities.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Advanced Materials

- Established methodology to predict delamination initiation and growth at critical details in composite structures.
- Generated a database for durability of textile forms and stitching as manufactured by resin transfer molding.
- Established criteria to assure damage tolerance of composite sandwich structures for small aircraft and rotorcraft.
- Initiated addressing certification issues of composite materials pertaining to rotorcraft.

Structural Safety

- Completed vertical drop test of a B737 fuselage section with overhead bins to deter-

mine their behavior under a survivable crash scenario.

- Completed assessment of the crash resistance of current rotorcraft, commuter, and transport fuel systems.
- Established guidelines for conducting Head Injury Criteria (HIC) component testing to supplement full scale testing.
- Published data on behavior of transport aircraft overhead stowage bins in a severe but survivable crash.

KEY FY 2002 PRODUCTS AND MILESTONES:

Advanced Materials

- Complete database on in-plane shear test methods and develop a new improved standard.
- Develop validated analytical methodology describing behavior of sandwich structures after impact event.
- Establish a database on verified safe design practices insuring structural integrity and damage tolerance of adhesive joints.
- Establish guidelines for probabilistic design certification.

Structural Safety

- Conduct a vertical drop test of currently in-service commuter aircraft with wing main spar seating.
- Conclude overhead stowage bin research.
- Conclude auxiliary fuel tank research.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program continues to focus on the areas listed at the beginning of the GOALS section above. Specific areas are damage tolerance of sandwich structures applicable to current and future aircraft fuselages, durability of textiles, and developing a database for certification of bonded composite joints in small aircraft. In addition, work will continue to develop data applicable to rotorcraft including high-cycle fatigue. Research in out years will encompass material behavior at elevated temperatures with application to engine parts and reusable launch vehicles. Within the structural safety area, a unified analytical modeling capability will be under development in order to reduce costly testing. The models will include the response of seats, restraint systems, seat attachments, and airframes under dynamic crash conditions. Other areas of research to be continued are crash resistance of fuel systems, determination of criteria for HIC and neck injury compliance. These criteria will be applicable to side facing seating in business jets. After conducting the vertical drop test of a currently in-service commuter aircraft, sufficient data will be available to compile a crash test database for all types of aircraft.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 59,792
FY 2001 Enacted	2,791
FY 2002 Request	2,974
Out-Year Planning Levels (FY 2003-2006)	12,699
Total	$ 78,256

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Advanced Materials	1,030	347	596	975	962
Structural Safety	1,029	462	493	819	808
Personnel Costs	835	803	1,109	937	1,091
Other In-house Costs	171	122	140	60	113
Total	**3,065**	**1,734**	**2,338**	**2,791**	**2,974**

Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	3,065	1,734	2,338	2,791	2,974
Development (includes prototyp	0	0	0	0	0
Total	**3,065**	**1,734**	**2,338**	**2,791**	**2,974**

A06b - Advanced Materials/Structural Safety Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
062-111 Advanced Materials Structures							
Advanced Materials	$962						
Established Methodology to Predict Delamination Initiation		◆					
Generate Data Base for Durability of Textile Forms		◆					
Establish Criteria for Damage Tolerance of Sandwich Structures		◆					
Complete Database on In-plane Shear Test Methods			◇				
Establish Guidelines for Probabilistic Design Certification			◇				
Develop Data Base on Verified Design Practice for Adhesive Joints			◇				
Develop Analytical Methods for Sandwich Structures			◇				
Develop Data Base on Damage Tolerance of Sandwich Structure				◇			
Durability and Damage Tolerance Data for Rotorcraft				◇			
Develop Certification Methodology for New Materials and Forms					◇		
Develop Certification Methodology for High Cycle Fatigue						◇	
Identify Data for Certification of Materials at Elevated Temperatures							◇
062-110 Structural Safety							
Structural Safety	$808						
Completed Vertical Drop Test of B737 Fuselage Section with Stowage Bins		◆					
Establish Guidelines for Conducting (HIC) Component Testing		◆					
Complete Assessment of the Crash Resistance of Fuel Systems		◆					
Complete Rotorcraft Ditching Research in Conjunction with the Navy				◇			
Publish Data on Crash Resistance of Transport Aircraft Stowage Bins		◆					
Conclude Overhead Storage Bin and Fuel Tank Research			◇				
Develop Analytical Capability to Model Aircraft Crash Events				◇			
Conduct a Vertical Drop Test of Commuter Aircraft with Main Spar Seating			◇				
Establish Crash Test Data Base					◇		
Develop Occupant Protection Criteria for Side Facing Seating						◇	
Improve Crash Resistance of Transport Fuel System							◇
Personnel and Other In-House Costs	$1,204						
Total Budget Authority	$2,974	$2,791	$2,974	$3,052	$3,129	$3,220	$3,298

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A06c Propulsion and Fuel Systems

GOALS:

Intended Outcomes: The FAA intends to improve system safety by enhancing the airworthiness, reliability, and performance of civil turbine and piston engines, their propellers, fuels, and fuel management systems. The major outcomes from this program include:

- Continued reliability and safety of general aviation operations by providing a safe transition to a new high octane unleaded aviation gasoline.
- Reduced the number of intrinsic turbine rotor failures by improved and standardized design and life management procedures.
- Improved melt processes for premium quality titanium alloys used for turbine rotor components.
- Improved manufacturing and quality practices to eliminate manufacturing induced anomalies in turbine rotor components.
- Reduced turbine engine failure/downtime and improved maintenance efficiency through advanced monitoring/diagnostic hardware and software.
- Continued reliability and safe use of Jet A fuel containing red dye contamination.
- Provided engineering support for the certification of the next generation general aviation piston and turbine engine.

Agency Outputs: The FAA maintains the airworthiness of aircraft engines, fuels, and airframe fuel management systems by issuing certification and advisory standards, and by supporting technical society specifications and recommended practices. The FAA also publishes technical information in various forms in the public domain. Technology may also be provided to the industry through hardware and software prototype demonstrations and technology workshops or various training medium. This research program provides the resources and oversight to deliver the necessary propulsion, fuel, and fuel transfer system technology in support of these agency outputs.

Customer/Stakeholder Involvement:

- The FAA collaborates with the engine industry to identify and implement cost-effective safety improvements that address incidents and accidents caused by in-service engine failures. This collaboration was initiated by the FAA Titanium Rotating Components Review Team. This team advises on the adequacy of industry standards and procedures to ensure the safety of the titanium alloy high energy rotating components of turbine engines. Industry participation is through working committees under the Aerospace Industries Association (AIA), including the Materials and Structures Committee, Rotor Integrity Subcommittee, Rotor Manufacturing Subcommittee and the Jet Engine Titanium Quality Committee.
- The AIA committees identify potential improvements in manufacturing process control, manufacturing and in-service inspection, and design and life management of failure critical rotating engine parts. These improvements are the basis for identifying specific R&D already underway or planned for this program.
- The FAA participates and provides leadership in testing capability for the Coordinating Research Council (CRC) Unleaded Aviation Gasoline Development Group. This group was formed in February 1995 to oversee research and testing for the development of the next generation of high octane unleaded aviation gasoline. EPA regulations and the Clean Air Act of 1990 mandate removal of lead from all gasoline. The critical need for the development of this fuel is reflected by the list of participants on the CRC group. Active participants and members of this group include: most major oil companies (U.S. and worldwide); general aviation airframe and engine manufacturers; general aviation user groups such as the Aircraft Owners and Pilots Association (AOPA), Experimental Aircraft Association (EAA), and General Aviation Manufacturers Association (GAMA); the research sponsor, the FAA New England Region Engine and Propeller Directorate; and the FAA Small Airplane Directorate in Central Region.

- The FAA sponsored Technical Oversight Group On Aging Aircraft (TOGAA) reviews technical aspects of the airworthiness assurance R&D activities. TOGAA has provided feedback on the progress of the turbine engine program over the last four years.
- The Subcommittee on Aircraft Safety of the FAA Research, Engineering and Development Advisory Committee was briefed on the propulsion program, an initiative that the subcommittee strongly supports.
- The FAA/industry initiative on turbine engine rotor integrity research in this program addresses National Transportation Safety Board (NTSB) recommendations A-90-89 and A-90-90.
- The program addresses recommendations of the FAA Titanium Rotating Components Review Team Report, which was presented to industry in a public meeting held in May of 1991.
- The Aerospace Industries Association convened an ad hoc group to study the effects of red dye contamination of Jet A fuel and to identify solutions to this problem. This effort has resulted in a program funded by the FAA, Defense Energy Support Center, Internal Revenue Service (IRS), Air Transport Association, and engine and airframe manufacturers. Additional funding from the oil refiners may be forthcoming.

Accomplishments: Results of the propulsion and fuels research program provided to engine and aircraft regulatory and industry stakeholders:

- Drafted an advisory circular on the correlation, operation, design, and modification of turbofan/jet engine test cells, which provide guidance on the testing of aircraft engines.
- Completed a training video production entitled; "Aircraft Turbine Engine Test Cell Correlation."
- Hosted and sponsored four annual joint FAA/Air Force public workshops with published proceedings on the application of probabilistic design methodology to gas turbine rotating components.
- Demonstrated integrated probabilistic rotor design and life management code (DARWIN™ version 3.2) for titanium alloys to provide commercial aircraft turbine engine manufacturers a tool to augment their current "safe life" management philosophy approach.
- Conducted DARWIN™ Code version 3.2 FAA/Industry training workshop.
- Demonstrated and delivered the DEFORM™ defect deformation micro code for analysis of titanium alloy defects during the turbine disk forging process.
- Determined the fleet octane requirement to be the single most critical parameter for development of high octane unleaded aviation gasoline.
- Completed validation of ground based procedures for determining octane requirements to be used in the development of a new high octane unleaded aviation gasoline.
- Participated in establishing matrix components to be used in developing candidate fuel formulations.
- Initiated engine tests on an industry-supplied fuel formulation.
- Completed report on engine octane requirements.
- Determined and defined detonation detection procedures for proposed American Society for Testing and Materials (ASTM) method to test unleaded replacement fuel(s).
- Issued final determination of fleet octane requirements for unleaded replacement in high fuel performance piston engines to be greater than 100 octane.
- Completed final report on in-service Jet A fuel sample analysis volatility survey.
- Completed report on the results of titanium melting enhancements.

R&D Partnerships:

A cooperative grant was awarded to the Southwest Research Institute, which has teamed with major engine manufacturers Pratt and Whitney, General Electric, Honeywell (AlliedSignal), and Rolls Royce-Allison. This work develops probabilistic-based turbine rotor material design and life management tools for improved rotor integrity. This work is closely coordinated with the U.S. Air Force Wright

Laboratory, which conducts complementary research, and with ongoing research activities of the FAA Engine Titanium Consortium sponsored under budget item A06e, Aging Aircraft. The FAA transfers the completed probabilistic engine design code versions for use by the industry via training workshops.

A research partnership has been initiated with the Specialty Metals Processing Consortium (SMPC) based at the Sandia National Laboratory; SMPC includes the Sandia Liquid Metals Processing Laboratory, Allvac, Oremet Titanium Co., RMI Titanium Co., Timet Co., General Electric Aircraft Engines, and Pratt & Whitney.

- The partnership exhibited by the CRC Unleaded Aviation Gasoline Development Group provides an arena to conduct research that is unprecedented in the aviation gasoline industry. The proprietary and competitive forces inhibiting progress, in the high octane aviation gasoline development, have been set aside. This allows the transfer of technology to and from government and industry to benefit all participants. Industry participants include Texaco, Exxon, Phillips Petroleum, Chevron, British Petroleum, Cessna, Raytheon (Beech), Teledyne Continental, and Textron Lycoming.
- A FAA contract with the Southwest Research Institute will determine an acceptable level of fuel dye contamination, which allows continuous safe turbine engine operation. The following organizations contribute funding to this effort: the FAA, Defense Energy Support Center, IRS, Air Transport Association, American Petroleum Institute, General Electric, Pratt & Whitney, Rolls Royce, Honeywell (AlliedSignal) and Boeing.
- Research to demonstrate the feasibility of a temporary (safety net) fuel will be will be done in partnership with the Cessna Aircraft Co.
- The program is benefiting from a close working relationship with the Airworthiness Assurance Center of Excellence. The research performed under this program is leveraged by the monetary and intellectual contributions of its core universities.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Completed rotor manufacturing induced anomaly database.
- Continued laboratory characterization and engine ground testing of preliminary industry-supplied candidate unleaded fuels using FAA test facilities.
- Began characterization and testing of industry supplied candidate fuels using FAA engine ground test facilities.
- Commercialized the DARWIN™ rotor design and life management code.
- Completed validation of the DARWIN™ rotor design and life management code for subsurface anomalies.
- Completed spin pit tests of disks that contain hard alpha defects to validate the FLIGHT_LIFE fracture mechanics module in DARWIN™.
- Completed report that defines an acceptable concentration of red dye contamination in Jet A fuel for continuous engine operation.
- KEY FY 2002 PRODUCTS AND MILESTONES:
- Complete validation of DEFORM™ forging microcode for tracking subsurface anomalies.
- Demonstrate DARWIN™ code version for surface anomalies.
- Verify hearth melt process models.
- Continue laboratory characterization engine ground testing of preliminary industry-supplied candidate unleaded fuels using FAA test facilities.
- Begin flight tests on industry-supplied candidate unleaded fuels.
- Complete demonstration of safety net unleaded fuel.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program continues development of a probabilistically-based turbine engine rotor design code with damage tolerance assessment. This code will be a life and risk management tool to augment the current “safe life” design approach for integration into engine manufacturer rotor design procedures. The application of this tool, as

an FAA-approved design certification standard, is intended to improve turbine rotor structural integrity while reducing the risk of failure.

The program also continues research on industry provided lead free fuel formulation candidates to replace the low lead aviation gasoline (ASTM D910 100LL) currently in use. These tests evaluate new fuel formulation effects on engine detonation, material compatibility, volatility, engine performance, storage stability, water reaction, emissions, fuel consumption and engine durability. In FY 2002 fuel tests using the FAA flight test aircraft will begin. All parameters impact on safe engine operation and all data supports eventual certification of a replacement fuel. In the event that a successful candidate fuel formulation is not available, the feasibility of a temporary (safety net) fuel will be demonstrated.

The program continues to develop rotor disk alloy material melt processes to establish commercial manufacturing standards that will eliminate metallurgical defects to produce premium quality, rotor grade alloy materials. Commercial aircraft accident history has shown that the presence of these defects in rotor disks have been the initiating cause of uncontained rotor failures. These failures are a major contributor associated with the engine failure fatal accident rate.

In FY 2002, the program will continue R&D support of the AIA Rotor Manufacturing Subcommittee to develop advanced manufacturing technologies. The purpose of this activity is to qualify and control the final surface manufacturing processes that could have an impact on rotor disk fatigue life.The FY 2002 program continues research to establish an improved understanding of the metallurgical, cold dwell time factors that can shorten fatigue life in titanium rotor disk alloys. The microstructure-based modeling capability developed by this activity will enable more accurate prediction of the risk of serious engine caused accidents.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 46,212
FY 2001 Enacted	8,182
FY 2002 Request	5,168
Out-Year Planning Levels (FY 2003-2006)	21,786
Total	$ 81,348

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Propulsion Systems Resear	3,643	1,761	1,754	6,994	3,944
Personnel Costs	1,126	932	1,230	1,114	1,079
Other In-house Costs	231	138	142	74	145
Total	**5,000**	**2,831**	**3,126**	**8,182**	**5,168**

Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	5,000	2,831	3,126	8,182	5,168
Development (includes prototyp	0	0	0	0	0
Total	**5,000**	**2,831**	**3,126**	**8,182**	**5,168**

A06c - Propulsion and Fuel Systems Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
063-110 Propulsion and Fuel Systems Research							
Turbine Engine Research	$3,096						
Validate the Probabilistic Rotor Design and Life Management Code (DARWIN) for Subsurface Defects		◆					
Commercialize Darwin Code		◆					
Demonstrate Probabilistic Integration Design Code – Surface Flaws			◇				
Deliver Probabilistic Rotor Design Code – Nickel Alloys					◇		
Complete Rotor Manufacturing Induced Anomaly Database		◆					
Verify Hearth Melt Process Models			◇				
Complete Ingot Surface Quality Model				◇			
Demonstrate the On-line Monitoring for Alloy Composition Control in a Commercial Electron Beam Melt Furnace						◇	◇
Develop Equations for Finite Element Modeling of Cold Dwell Fatigue					◇		
Develop Computer Model for Cold Dwell Fatigue Damage Evolution and Failure in Titanium						◇	
Unleaded Fuels and Fuel System Safety Research	$848						
Continued Laboratory Characterization of Industry Supplied Preliminary Candidate Fuels		◆	◇				
Begin Laboratory Characterization and Engine Ground Testing of Industry Supplied Candidate Unleaded Fuels		◆					
Complete Determination of Acceptable Concentration of Red Dye Contamination in Jet A Fuel for Continuous Engine Operation		◆					
Begin Flight Tests on Industry Supplied Candidate Fuels			◇				
Begin Fleet Evaluation of Candidate Unleaded Aviation Gasoline				◇			
Complete Demonstration of Safety Net Unleaded Fuel			◇				
Personnel and Other In-House Costs	$1,224						
Total Budget Authority	$5,168	$8,182	$5,168	$5,278	$5,381	$5,513	$5,614

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A06d Flight Safety/Atmospheric Hazards Research

GOALS:

Intended Outcomes: The FAA intends to improve aircraft safety by developing technologies, technical information, procedures, and practices. These measures help ensure safe operation of the civil fleet in icing conditions and in the electromagnetic environment, and address safety issues pertaining to software, digital flight controls and avionics systems.

In the area of aircraft icing, the program focuses on establishing operating rules and procedures for deicing and anti-icing to ensure a clean aircraft at takeoff. It also focuses on developing technology to determine the existence of frozen contamination and the failure of anti-icing fluids on critical aircraft surfaces. It addresses characterization of the atmospheric icing environment by collecting and analyzing supercooled cloud and precipitation data. It also develops technology (ice protection and detection), certification requirements, and advisory material to ensure that aircraft meet performance, stability, and control safety standards during or after in-flight operation in icing conditions.

The software and digital systems safety program addresses aircraft safety and certification issues. These issues involve the use of emerging, highly complex, software based digital flight controls and avionics systems in flight essential and flight critical applications. The electromagnetic hazards to aircraft systems program focuses on protecting aircraft electrical and electronic systems against the effects of lightning and High Intensity Radiated Fields (HIRF). HIRF effects may come from airborne, shipborne and ground based emitters. The program also focuses on the effects of spurious emissions from portable electronic devices, i.e., tape players, laptop computers, cellular phones, etc.

Agency Outputs: The FAA establishes rules for aircraft operation in icing conditions and the electromagnetic environment, software, digital flight controls, avionics systems, and electromagnetic hazards. It also publishes Advisory Circulars (AC) to outline acceptable means for meeting the rules and disseminates various forms of technical information to agency certification and airworthiness specialists, agency inspectors, and to the aircraft and avionics industry. The program fosters development of promising technologies such as sensors, to detect frozen contamination, and anti-icing fluid failure. The aircraft icing project joins with the Society of Automotive Engineers (SAE) in annual updates to aircraft holdover time guidelines. These provide time estimates of the effectiveness of de/anti-icing fluids.

Customer/Stakeholder Involvement: The program directly supports the FAA Strategic Plan Mission Goal for Safety: By 2007, reduce U.S. aviation fatal accident rates by 80 percent from 1996 levels. The program directly supports the Safety Strategic Focus Area of Accident Prevention. It does this through enhancements to aircraft certification, inspection, and maintenance relative to atmospheric hazards and advanced software and digital systems. It also directly supports Challenge 2000 through research and increased awareness in the area of software and standardization efforts among the certification directorates. In addition, it supports the free flight initiative, addressing highly integrated avionics and ground-based systems safety and certification issues, using very complex software. A key supporter is the Aviation Rulemaking Advisory Committee (ARAC) Electromagnetic Effects Harmonization Working Group (EEHWG).

The ARAC Flight Test Harmonization Working Group (FTHWG) addresses performance and handling requirements standardization, and guidance material for operation in icing conditions. The ARAC Ice Protection Harmonization Working Group (IPHWG) addresses definition of an icing environment that includes Supercooled Large Droplets (SLD) and means, such as ice detectors, to discriminate between conditions within and outside the certification envelope and to warn flightcrews of ice accumulation on critical surfaces. An SAE committee also address aircraft lightning protection (AE-2). This committee develops ACs, test standards, and related users manuals to improve flight safety. The FAA provides leadership to the SAE G-12 Aircraft Ground Deicing Committee. This committee addresses holdover time guideline updates,

standards establishment for de/anti-icing methodologies and fluids, and sensor criteria to determine the existence of frozen contamination. It also addresses the failure of anti-icing fluids on critical aircraft surfaces.

Accomplishments: The program provided aircraft icing regulatory guidance and operating procedures to aircraft manufacturers and operators. This consisted of technical reports, handbooks, information bulletins, ACs and rules. Since 1992, the program has updated or issued two ACs, five technical bulletins, and the Aircraft Icing Handbook (twice), and it has published more than 45 technical reports or papers, including reports on ice phobic technologies. It has held international conferences on aircraft ground deicing (more than 600 participants from more than 10 countries), on aircraft in-flight icing (more than 400 participants from 20 countries), and on mixed-phase and glaciated icing conditions (more than 50 participants from five countries). It has also issued holdover time guidelines for deicing and anti-icing fluids.

In the area of software and digital systems safety, a report was published addressing structural coverage testing of aircraft software. Numerous forms of coverage were addressed including software mutation testing methods. A Commercial-off-the-Shelf (COTS) software and hardware study was completed where guidelines, verification methods and assessment criteria, for both aircraft software and hardware, were developed. In addition, detailed design data and a hardware implementation plan were developed and published as part of a complex electronic hardware case study.

In the electromagnetic hazards area, the program published three SAE lightning documents addressing the aircraft lightning environment and related test waveforms, certification of aircraft electrical systems and aircraft lightning zoning. The program also published a HIRF users guide for AC 20-1317, a report on in-service lightning strikes and continued the lightning strike characterization study to better define the lightning environment.

R&D Partnerships: The program has established many cooperative relationships, including the following:

- ARAC, EEHWG international certification authority/industry forum – HIRF environment, User's Guide for AC 20-1317.
- SAE–AE2 Lightning Protection of Aircraft, Lightning Environment, Waveforms and Testing Standard, Aircraft Zoning Standard, and User's Manual for AC 20-136.
- RTCA Special Committee-135, "Environmental Conditions and Test Procedures for Airborne Equipment."
- RTCA Special Committee-190, "Software Considerations in Airborne Systems and Equipment Certification."
- Multiyear FAA/NASA interagency agreement with Langley Research Center to cooperate in the assessment of software-based digital flight controls and avionics systems and electromagnetic hazards research.
- Letter of agreement to leverage HIRF certification research with Sandia Corporation, Army Directorate for Applied Technology, Test and Simulation, and ORION International Technologies, Incorporated.
- Certification Authorities Software Team (CAST) consisting of avionics software systems certification authorities from U.S., Europe and Canada.
- Cooperative efforts on aircraft icing activities with the NASA Glenn Research Center.
- Aircraft icing has more than six grants and agreements in place with academia and other government agencies to "leverage" interests and capabilities.
- An international agreement exists with Transport Canada on research on aircraft ground deicing issues.
- An international memorandum of cooperation exists with the Meteorological Service of Canada for research on in-flight icing conditions.
- An Interagency agreement with the Air Force for development of a new icing tanker for military and commercial use.
- ARAC IPHWG directly supported with data on and analysis of SLD conditions in the atmosphere.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Aircraft Icing

- Continued consolidating and assessing atmospheric icing data aloft.
- Evaluated time effectiveness and aerodynamic performance of environmentally friendly and other modern fluids.
- Published report on improvement of icing simulation methods.
- Published report on documentation and quantitative comparison of ice shapes.
- Published report on residual and intercycle ice.
- Published report on acquisition of atmospheric icing data from operational aircraft.
- Published report on hot water deicing.
- Software and Digital Systems Safety.
- Published report on acceptance criteria for using Software Service History (SSH) on certification projects.
- Evaluated acceptance criteria/guidelines and structural coverage issues for Object Oriented Technology (OOT).
- Completed investigation of COTS software and hardware protection architectures and techniques.

Electromagnetic Hazards to Aircraft Systems

- Published HIRF User's Guide for AC 20-1317.
- Published report on spurious emissions from cell phone and effects on aircraft navigation equipment.
- Published report from lightning strike characterization study for definition of aircraft lightning environment.
- Published updated report for in-service lightning strike data and analysis.
- Published Lightning User's Manual for AC 20-136.

KEY FY 2002 PRODUCTS AND MILESTONES:

Aircraft Icing

- Evaluate time effectiveness and aerodynamic performance of environmentally friendly and other modern fluids.
- Complete study of airfoil sensitivity to location, size, and shape of geometric representations of ice shapes.
- Publish report on recycled glycol technologies/utilization.
- Complete acceptance criteria for icing simulation tools.
- Interim report on procedures and methods for laboratory determination of fluid holdover times.

Software and Digital Systems Safety

- Completed investigation of use of wrappers as a protection methodology for safety of COTS software in airborne systems.
- Complete study of OOT structural coverage tools issues and acceptance criteria/guidelines.
- Electromagnetic Hazards to Aircraft Systems.
- Revise RTCA DO-160 and prepare advisory circular with updated electromagnetic compatibility test methods and requirements for large systems.
- Continue Electro Magnetic Interference/Electro Magnetic Compatibility (EMI/EMC) continued protection integrity investigation for aging aircraft systems and components and recommend methods for detecting EMC performance degradation.
- Publish Protection Integrity Report.

FY 2002 PROGRAM REQUEST:

- Aircraft Icing
- Continue to collect and assess the global atmospheric icing environment data, including steps to acquire data from operational aircraft.
- Continue investigation of procedures and methods for laboratory determination of fluid holdover times.
- Continue investigation and assessment of ice detection technologies.

- Reassess and initiate investigation of promising ice phobic technologies.

Software and Digital System Safety

- Continue research relative to emerging flight safety and certification issues identified by CAST and RTCA SC-190 efforts.

Electromagnetic Hazards to Aircraft Systems

- Continue research relative to lightning protection, HIRF protection, electromagnetic compatibility, in-service lightning data, single event effects/upset and continued integrity research.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 54,303
FY 2001 Enacted	4,100
FY 2002 Request	4,150
Out-Year Planning Levels (FY 2003-2006)	17,674
Total	$ 80,227

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Flight Safety	0	261	345	167	165
Atmospheric Hazards	705	1,233	1,598	2,490	2,452
Personnel Costs	1,127	973	1,744	1,349	1,388
Other In-house Costs	231	152	157	94	145
Total	**2,063**	**2,619**	**3,844**	**4,100**	**4,150**

Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	2,063	2,619	3,844	4,100	4,150
Development (includes prototyp	0	0	0	0	0
Total	**2,063**	**2,619**	**3,844**	**4,100**	**4,150**

A06e Aging Aircraft

GOALS:

Intended Outcomes: The FAA intends to improve aviation safety by developing technologies, technical information, procedures, and practices that ensure the continued airworthiness of aircraft structures and components in the civil transport fleet. The aging aircraft research program focuses principally on:

- Analytical methodologies development and validation to predict the onset of Widespread Fatigue Damage (WFD) and residual strength of aircraft structures.
- Nondestructive Inspection (NDI) techniques development and validation to detect and quantify damage in the forms of corrosion, cracking, disbonding, and material processing defects.
- Flight and landing loads and airworthiness standards updates and validation by acquiring and analyzing actual usage data for civil transport aircraft.
- Maintenance and repair requirements and procedures establishment for airframes.
- Damage tolerance methodology, health and usage monitoring methodology, and updated design load spectrums (based on actual usage) for the rotorcraft fleet.
- Development of information, technologies, and techniques to ensure the continued safe operation of aircraft electrical and mechanical systems.

Agency Outputs: The FAA establishes rules for aircraft certification, inspection, maintenance, and repair and publishes Advisory Circulars (AC) to outline acceptable means for compliance. Additionally, the agency disseminates technical information in various forms to its airworthiness inspectors and to industry. These outputs improve aircraft construction and maintenance practices. The objective of all of these products is to improve flight safety by increasing the continued airworthiness of aircraft. The aging aircraft research program provides the technical information necessary to support these agency outputs.

Customer/Stakeholder Involvement: The FAA has established an extensive network for collaboration in aging aircraft research, including:

- The Aviation Rulemaking Advisory Committee (ARAC) is an FAA/industry forum established to ensure that industry's resources are used to their fullest extent and that the agency's rulemaking achieves intended results. ARAC also identifies requirements and priorities for supporting R&D activities.
- The FAA sponsored Technical Oversight Group on Aging Aircraft (TOGAA) ensures effective coordination of aging aircraft program activities with related activities in DOD and industry. TOGAA meets several times a year to assess program progress and review research priorities in light of technical progress and the needs of aircraft manufacturers, operators, and maintainers.
- The Subcommittee on Aircraft Safety of the FAA Research, Engineering and Development Advisory Committee completed a review of the aging aircraft program. The program described here is fully responsive to the advice of the subcommittee.
- The aging aircraft program directly supports the Aviation Safety Research Act of 1988 (Public Law 100-591). This Act increased the scope of the FAA's mission to include research on methods for improving maintenance technology and detecting the onset of cracking, delamination, and corrosion of aircraft structures. In particular, this legislation directed the FAA to focus attention on maintaining the airworthiness of the aging commercial fleet.
- The aging nonstructural systems research program is the primary vehicle for supporting the recommendations of the White House Commission on Safety and Security, which states that "in cooperation with airlines and manufacturers, the FAA's Aging Aircraft Program should be expanded to cover non-structural systems."

Accomplishments: A series of four panel tests were completed at the Full-Scale Aircraft Structural Test Evaluation and Research

(FASTER) facility, located in the Safety Research and Development area at the FAA William J. Hughes Technical Center. The data obtained from the tests will be used to validate analytical models being developed by the FAA and NASA. All testing is monitored using state-of-the-art video equipment for continuous observation. The test fixture is capable of applying pressurization, longitudinal, hoop, and shear loads to a curved panel test specimen to simulate realistic operational conditions in the laboratory.

The FAA's Airworthiness Assurance Nondestructive Inspection Validation Center (AANC), located in Albuquerque, NM, continues to expand. The Center has specialized in the performance of comprehensive, independent, quantitative evaluations of new and enhanced NDI, maintenance, and repair techniques. The hangar facility contains several aging aircraft, large fuselage sections, and a sample structural defect library. Aircraft test articles include a B-747, B-737, DC-9, HU-25A, Fairchild Metro II, UH-1H, and TH-57 aircraft.

Civil transport flight and ground loads data collection programs have been reestablished for large as well as small transport aircraft. To collect flight loads data, optical quick access recorders have been installed on several B-737, B-757, B-767, MD-82, and A-320 aircraft, and usage data is being analyzed. Similar recording technology is being employed to collect data on BE-1900D and CRJ commuter aircraft.

The FAA is conducting a series of video landing parameter surveys at high capacity commercial airports to better understand typical contact conditions for a wide variety of aircraft and airports and how these conditions relate to current aircraft design criteria and practices. Airplane landing contact parameters have been obtained from the analysis of video images recorded during surveys conducted at representative high activity commercial large transport and commuter airports. To date, five such surveys have been completed at John F. Kennedy International Airport, Ronald Reagan Washington National Airport, Honolulu International Airport, London City Airport in the United Kingdom, and Philadelphia International Airport. Reports have been published on the first three surveys. Data collection is continuing at the four-camera video landing survey facility that was established at the Atlantic City International Airport to collect landing data under fair and poor weather conditions.

In partnership with the Naval Air Systems Command and the Office of Naval Research, the FAA began development of Arc Fault Circuit Breakers (AFCB) to replace thermal circuit breakers currently in use. Unlike thermal breakers, AFCBs can detect electrical arcing and rapidly remove power to the affected circuit, drastically reducing the chances of fire and related damage. AFCB prototypes were successfully tested aboard the FAA 727.

In support of the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC), the FAA completed intrusive wiring inspections of six recently retired transport aircraft. Samples were removed from the aircraft and subjected to an extensive battery of laboratory tests. Results of the inspections are documented in a report prepared for the ATSRAC.

R&D Partnerships: Program activities are closely coordinated with related initiatives being undertaken by industry, NASA and DOD. The FAA, DOD, and NASA have cosponsored several conferences in the area of aging aircraft and airworthiness assurance. Interagency agreements are in place between the FAA and NASA, U.S. Navy, U.S. Air Force, and DOE. International agreements are in place between the FAA and the regulatory authorities in the United Kingdom, The Netherlands, Australia, and Canada. A Memorandum of Cooperation is in place between the FAA and Russia.

The FAA Center of Excellence for Airworthiness Assurance (AACE), established in FY 1997, was formed with a broad mission in aircraft and aircraft systems safety research. AACE is a consortium consisting of eight core universities, Sandia National Laboratories, and more than 100 affiliates from government, industry, and academia.

The Center for Aviation Systems Reliability (CASR) is a consortium of four universities, Iowa State University, Northwestern University, Wayne

State, and Ohio State University, formed to develop NDI techniques.

AANC is a partnership with Sandia National Laboratory to test and evaluate inspection techniques in a realistic hangar environment and to enhance technology transfer.

The Engine Titanium Consortium (ETC) is comprised of Iowa State University, Pratt & Whitney, General Electric, and Allied-Signal. It was formed to develop methods for the inspection of engine components.

Numerous research grants have been awarded and are in place with universities and not-for-profit laboratories to leverage their interests and capabilities. Cooperative Research And Development Agreements (CRDAs) are in place with several airline operators as part of the flight loads data collection program.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Completed development of an engineering manual with guidelines to predict the onset of WFD and residual strength and structures.
- Released an enhanced version of a user-friendly software tool for damage tolerance analysis and design of aircraft repairs for commuter aircraft. Completed development of a methodology for the prediction of the in-flight loads in the empennage of a general aviation aircraft.
- Published flight loads data reports for various transport and commuter aircraft models.
- Published landing loads data reports from video landing parameter surveys.
- Published results of testing of aged circuit breakers to determine whether their performance had degraded below the original manufacturer's specification.
- Enhanced fracture mechanics computational capabilities used for damage tolerance analyses of structural helicopter components.
- Developed crack-growth-based predictive methodology for inspection and maintenance programs for non-rotating, safety critical components of aircraft engines.
- Continued development of first generation, prototype arc fault circuit interrupter for aircraft applications.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Continue enhancement to a user-friendly software tool for the damage tolerance analysis and design of aircraft repairs for commuter aircraft.
- Continue the FAA/industry jointly funded investigation of the susceptibility of an aging airframe to WFD.
- Continue development and validation of enhanced inspection systems for engine components.
- Continue development and validation of inspection techniques to detect damage in airframe structures typical of WFD.
- Continue flight and landing loads data collection, analysis, and reduction for large transport and commuter aircraft.
- Complete validation study on liquid penetrant inspection methodology.
- Develop ultrasonic contact transducer for crack detection.
- Complete development of prototype risk assessment algorithms for aircraft wiring.
- Begin development of 28v DC Arc Fault Circuit breakers.
- Complete testing of aged power control relays and remotely controlled circuit breakers to determine whether the performance of these devices has degraded below original manufacturer specifications.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program continues to focus on the areas listed at the beginning of the GOALS section above. The near-term emphasis continues on a better understanding of the effects of WFD; developing supplemental inspection requirements to better account for airframe and component damage; developing and validating enhanced inspection techniques; and, understanding the effects of aging on nonstructural systems and developing technologies to eliminate or mitigate potential hazards associated with these effects.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 202,367
FY 2001 Enacted	33,311
FY 2002 Request	27,111
Out-Year Planning Levels (FY 2003-2006)	113,709
Total	$ 376,498

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Aging Aircraft	18,466	11,945	17,714	29,250	22,462
Personnel Costs	2,551	2,381	3,547	3,451	4,041
Other In-house Costs	523	368	333	610	608
Total	**21,540**	**14,694**	**21,594**	**33,311**	**27,111**

Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	21,540	14,694	21,594	33,311	27,111
Development (includes prototyp	0	0	0	0	0
Total	**21,540**	**14,694**	**21,594**	**33,311**	**27,111**

A06e - Aging Aircraft Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
065-110 Aging Aircraft							
WFD and Residual Strength Analysis	$7,225						
Completed Development of an Engineering Manual with Guidelines for Onset of Widespread Fatigue Damage (WFD)		◆					
Complete Destructive Examination of Aging Airframe and Publish Results					◇		
Continue Development & Validation of Inspections Techniques		◆	◇	◇			
Develop Prototype for Detection of WFD-Size Cracks					◇		
Commuter Aircraft Requirements	$994						
Released Enhanced Version of User Friendly Software Tool for Damage Tolerance Analysis and Design of Aircraft Repairs for Commuter Aircraft		◆					
Continue Enhancement of User Friendly Software Tool for Damage Tolerance Analysis and Design of Aircraft Repairs for Commuter Aircraft		◆	◇	◇			
Airborne Data Monitoring Systems	$1,514						
Continue Data Collection Analysis on Flight Loads		◆	◇	◇	◇	◇	◇
Conduct Video Landing Parameter and Loads Survey at Commercial Airports		◆	◇	◇	◇	◇	◇
Published Flight Loads Data Reports for Various Transport and Commuter Aircraft Models		◆					
Inspection for Engines	$3,534						
Continue Development and Validation of Enhanced Inspection Systems for Engine Components		◆	◇	◇	◇	◇	◇
Complete Development of Ultrasonic Inspection Tools for Engines						◇	
Rotorcraft Structural Integrity	$808						
Complete Final HUMS Advisory Circular (AC) and Compliance Guidance for Part 29 & 27 Rotorcraft						◇	
Update AC 29-2A and 27-1 for Fatigue and Damage Tolerance						◇	
Aging of Nonstructural Systems	$8,387						
Develop First Generation, Prototype Arc-Fault Circuit Interrupter for Aircraft Applications		◆	◇	◇			
Complete Assessment of Feasibility of Service Life for Aircraft Wire				◇			
Develop a Prototype Testing or Inspection Device to Identify Hazardous Conditions Involving Aircraft Wire				◇			
Complete a Report on Performance of Aged Circuit Breakers		◆					
Begin development of 28v DC Arc Fault Circuit breakers			◇	◇	◇		
Complete Testing of Aged Power Control Relays and Remotely Controlled Circuit Breakers to Determine if the Performance of these Devices has Degraded Below Original Manufacturer Specifications			◇				
Personnel and Other In-House Costs	$4,649						
Total Budget Authority	$27,111	$33,311	$27,111	$27,634	$28,113	$28,750	$29,212

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A06f Aircraft Catastrophic Failure Prevention Research

GOALS:

Intended Outcomes: The FAA intends to improve system safety by developing technologies and methods to assess risk and prevent potentially catastrophic defects, failures, and malfunctions in aircraft, aircraft components, and aircraft systems.

The Aircraft Catastrophic Failure Prevention Program focuses principally on using historical accident data and National Transportation Safety Board (NTSB) recommendations to examine and investigate known problem areas, such as:

- Turbine engine uncontainment events, including mitigation and modeling of uncontainment and aircraft vulnerability to uncontainment (AC20-128, phase II).
- Propulsion malfunctions and potential solutions (with the help of industry).
- Explosive fuel tank issues, where the current focus is on the fuel quantity indication system wiring and the impact of sulfide deposits.

Agency Outputs: The FAA establishes certification criteria for aircraft and publishes Advisory Circulars (AC) to outline acceptable means for meeting these rules. The program's objective is to ensure safe aircraft operation in the public domain.

The Aircraft Catastrophic Failure Prevention Program provides the technical information necessary to support these agency outputs.

Customer/Stakeholder Involvement: The FAA continues to establish collaborative efforts with organizations such as the following to ensure a balanced, responsive Aircraft Catastrophic Failure Prevention Program:

- The Aviation Rulemaking Advisory Committee (ARAC) is a FAA-industry forum established to ensure that agency rulemaking achieves intended results, and that the resources of industry are fully utilized in accomplishing these results. ARAC also identifies requirements and priorities for supporting R&D activities. The ARAC Powerplant Installation and Harmonization Working Group (PPIHWG) provides guidance to this program for the update of AC20-128.
- The FAA sponsors a series of workshops on turbine engine uncontainment characterization, modeling, and mitigation. This forum brings together industry and government (civil and military) to review progress on this subject and to recommend future courses of action.
- The FAA has developed partnerships with industry through the ARAC PPIHWG to collaborate in developing a modeling toolkit for the modeling of engine uncontainment events.
- The FAA supports the Aerospace Industries Association (AIA) - Transport Committee (TC) report examining propulsion system malfunctions and inappropriate crew response. This project brings industry and the FAA together to recommend courses of action to foster safety and to develop associated regulations and advisory materials.
- The ARAC Fuel Tank Harmonization Working Group advises the program on issues related to fuel tank explosions.
- The program also responds to Public Law 100-591 (the Aviation Safety Act) and Public Law 101-508 (the Omnibus Reconciliation Act), which together established the aircraft catastrophic failure prevention program.

Accomplishments: Results of the catastrophic failure prevention program research are provided to certification officials to form the technical basis for rule changes as well as new or modified ACs. Results are also provided to airframe and engine manufacturers and designers. Recent accomplishments include:

- Developed the uncontainment database and experimental test data needed by ARAC to establish new guidance for uncontained turbine engine failure methodology.
- Developed improvements to an aircraft vulnerability model to predict aircraft vulnerability to engine uncontainment events.
- Completed development of advanced material DYNA-3D fabric tensile failure model.

- Completed experimental work required for aircraft material uncontained engine failure analysis.
- Developed sulfide deposits in the laboratory for study of fuel quantity indication systems.

R&D Partnerships: Through interagency agreements, grants, and contracts, program activities are closely coordinated with governmental, academic, and commercial experts to leverage the full advantage of existing knowledge and technologies. Significant program benefits are realized from the following agreements:

- Interagency agreement with Naval Air Warfare Center Weapons Division, China Lake, which partners with Boeing to modify military vulnerability analysis tools. These tools are used in examining the vulnerability of commercial transport aircraft to turbine engine uncontainment events.
- Interagency agreement with Lawrence Livermore National Laboratory, which partners with Boeing, Honeywell Engines, and Pratt & Whitney, to develop a modeling toolkit to address turbine engine uncontainment events modeling.
- Center of Excellence contract with SRI, which partners with University of Dayton Research Labs and Arizona State University, and in-kind support provided by Boeing and B. F. Goodrich.
- Interagency Agreement with NASA Glenn for cooperation on turbine engine uncontainment.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Engine Uncontainment Research

- Delivered a prototype aircraft vulnerability model for evaluation of uncontained engine debris hazards in cooperation with ARAC.
- Continued modifications to vulnerability code based on airframe manufacturers' evaluations.
- Continued expansion of the advanced material DYNA-3D model to include failure modes and fabric interaction identified in system impact testing.
- Performed full scale tests of advanced armor design concepts.

Explosive Fuel Tank Issues

- Continued research on copper-silver sulfide contamination on fuel quantity indicating systems.

Propulsion Malfunction

- Developed a plan, in conjunction with Flight Standards, for producing propulsion malfunction database.

KEY FY 2002 PRODUCTS AND MILESTONES:

Engine Uncontainment Research

- Complete the Uncontained Engine Debris Damage Assessment Model (UEDDAM) vulnerability code.
- Complete work on a calibrated design tool to model engine uncontainment debris impact with titanium and aluminum aircraft materials.
- Complete advanced containment and mitigation material DYNA-3D model for designers.
- Develop a plan for an engine crack detection monitoring system.
- Complete work on the calibrated design system for certification purposes.

Propulsion Malfunction

- Deliver a beta version of the propulsion malfunction database.

Explosive Fuel Tank Issues

- Continue research into explosive fuel tank issues, focusing on the formation of sulfidation products in fuel tanks and complete second interim report on sulfide deposits.
- Initiate research into hazards of fuel pump malfunctions that could become an ignition source.

FY 2002 PROGRAM REQUEST:

The program continues to modify aircraft vulnerability codes to incorporate suggestions obtained from airframe manufacturers' evaluations. It continues to work toward the certification of a calibrated design system that examines engine uncontainment by modeling the

mitigation effects of advanced materials and improving penetration equations for aluminum and titanium. Uncontained engine failures are the result of rotating component failures. The program will initiate development of technologies to detect these conditions during operation and prevent the failure from occurring in service.

The program also develops engine malfunction materials to better define a variety of propulsion malfunctions, including turbine engine surge. Materials will be used as input to simulator programs and as a resource for future monitoring programs.

Lastly, the program will continue to be responsive to the ARAC Fuel Tank Harmonization Working Group in examining issues and potential solutions to the explosive fuel tank issue.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 19,810
FY 2001 Enacted	2,776
FY 2002 Request	2,794
Out-Year Planning Levels (FY 2003-2006)	11,785
Total	$ 37,165

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Aircraft Catastrophic Failure Prevention Research	3,289	1,329	1,308	2,131	2,101
Personnel Costs	590	397	607	610	621
Other In-house Costs	121	61	66	35	72
Total	**4,000**	**1,787**	**1,981**	**2,776**	**2,794**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	4,000	1,787	1,981	2,776	2,794
Development (includes prototypes)	0	0	0	0	0
Total	**4,000**	**1,787**	**1,981**	**2,776**	**2,794**

A06f - Aircraft Catastrophic Failure Prevention Research Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
066-110 Aircraft Catastrophic Failure Prevention Research							
Engine Uncontainment Research	$1,251						
Delivered Prototype Aircraft Vulnerability Model for Evaluation of Uncontained Engine Debris Hazards		◆					
Continue Modifications to Vulnerability Code Based on Airframe Manufacturers' Evaluations		◆					
Continued Expansion of Advanced material Model in DYNA-3D to Include Failure Modes and Fabric Interaction		◆					
Complete Calibrated Design Tool To Model Uncontainment Debris Impact With Titanium and Aluminum			◇				
Complete DYNA-3D Model of Advanced Containment & Mitigation Materials			◇				
Complete UEDDAM Vulnerability Model			◇				
Complete Calibrated Design System for Certification Purposes			◇				
Complete Plan for Engine Crack Detection Monitoring System			◇				
Demonstrate Engine Crack Detection Monitoring System					◇		
Explosive Fuel Tank Issues	$425						
Continue Research On Copper-Silver Sulfide Contamination		◆					
Complete Second Interim Report on Sulfide Deposits			◇				
Continue Work on Sulfide Deposits				◇			
Initiate Research Into Hazards Of Fuel Pump Malfunctions			◇				
Complete Recommendations for Fuel Pump Malfunctions						◇	
Conduct Research on ARAC Recommendations to Eliminate Fuel Tank Explosions					◇	◇	
Develop Appropriate Technologies to Prevent Fuel Tank Explosions							◇
Propulsion Malfunction	$425						
Develop a Plan for Producing Propulsion Malfunctions Database		◆					
Deliver Beta Version of Propulsion Malfunction Database			◇				
Complete Population of Propulsion Malfunction Database				◇			
Develop Recommendations for Propulsion Malfunction Diagnostics					◇		
Personnel and Other In-House Costs	$693						
Total Budget Authority	$2,794	$2,776	$2,794	$2,854	$2,910	$2,982	$3,039

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A06g Aviation Safety Risk Analysis

GOALS:

Intended Outcomes: The FAA will continue to increase its collaboration with industry in their mutual search for programs and systems with true potential for increasing aviation safety. Accordingly, the partners will build on their previous collaboration to improve risk assessment, safety performance measurement and the shared use of safety-related data. The Aviation Safety Risk Analysis (ASRA) Program focuses primarily on:

- Design/Development and/or enhancement of risk management/decision support tools embedded in FAA analytical systems, e.g., flight standards service Safety Performance Analysis System (SPAS), and the aircraft certification service safety management program products. These tools encompass particulars about air carriers, aircraft design, aircraft maintenance, discrepancy reports, repair stations (both domestic and foreign) aviation training schools, and air personnel.
- Development of advanced risk assessment indicators/safety performance measures and graphical techniques. These allow the FAA to more effectively and efficiently use information contained in various FAA and industry databases.
- Establishment of a forum with industry to exchange aviation risk assessment/risk management and safety performance measures models and methodologies.
- Development of an improved safety analysis methodology that will be used to certify new products by including human factors and operational issues.
- Development of a risk-based process to improve aircraft certification oversight activities and promote synergy with policy development.
- Development and/or enhancement of the Maintenance Malfunction Information Reporting (MMIR) System with capabilities to track critical helicopter parts, to capture part utilization/performance data, and to perform trend analysis on the captured data.
- Complete research materials necessary to support the development of Advisory Circulars on Eligibility and Evaluation of U.S. Military Flight Safety Critical Aircraft Parts (FSCAP) for other critical aircraft systems.
- Development of guidelines for using onboard Built-in Test Equipment (BITE) as approval to return aircraft to service after maintenance.

Agency Outputs: The Federal Aviation Act of 1958 and the Federal Aviation Regulation (FAR) provide the FAA the statutory authority and responsibility to conduct surveillance of air operators, air agencies, aircraft, and airmen to ensure conformance with the FAR and aviation safety standards. The outputs from the Aviation Safety Risk Analysis research program improve the data, data gathering techniques, analysis, and risk management/decision support tools needed for FAA certification, surveillance, investigation, and certificate management processes. These outputs enable systematic risk assessment and safety performance measurement to take proactive steps to reduce the rate of aviation related accidents and incidents. Based on insights from risk analysis, the FAA targets and increases its leverage of aviation safety inspector and certification engineering resources.

Customer/Stakeholder Involvement: The Federal Aviation Authorization Act of 1996 required that the Administrator give "high priority to developing SPAS." The legislation also called for deployment of SPAS II, initiated in FY 1997, completed in December 1999. ASRA enhances SPAS decision support capabilities through additional risk analysis/predictive models, expert system capabilities, and critical safety performance indicators.

In 1997, the Flight Standards Service introduced their new business process, the Air Transportation Oversight System (ATOS); a system-based approach to FAA certification, surveillance, and certificate management oversight. ATOS is designed to provide the FAA with the people, procedures, equipment, facilities, software, tools, and materials necessary to make surveillance more systematic and better targeted to deal with

identified risks. In support of this effort, the ASRA program will provide: systems engineering; analyses in the form of design of safety performance measures, data sources, analysis methodologies, information presentation; and system safety risk assessment research (such as hazard analysis, design of risk indicators, Markovian Models, and Aviation System Risk Models).

The ASRA Program responds directly to the Safer Skies Agenda, recommendations in the Challenge 2000 Report and the FAA 90-day Safety Review. Maximum information sharing alerts both the FAA and industry to pending aviation safety-related problems. Developing a certification and surveillance program built on targeting resources to address safety risks ensures that corrective action is taken much sooner. Thus, the primary beneficiaries of this effort are the general flying public.

Several analytical tools, such as SPAS, will be used by the Department of Defense in their oversight of defense contract carriers and charters.

The FAA worked with Helicopter Association International (HAI) to develop and release the maintenance malfunction information reporting system. This software tool has improved the collection, storage, and transfer of service difficulty reports and part warranty information.

Data improvement and standardization efforts respond to recent Congressional hearings and the General Accounting Office (GAO) report recommends that the FAA increase the quality and timeliness of their aviation safety data. More importantly, analytical and decision support tools rely on high quality data to identify potential safety risk areas.

Accomplishments: Full deployment of SPAS II was initiated in FY 1997 and was completed by December 1999. This is a computer-based analytical tool used by FAA aviation safety inspectors and certification engineers, as well as DOD aviation analysts, to support the oversight activities of FAA certificate holders (i.e., air operators, air agencies, aircraft, and air personnel). A study was initiated to establish baseline risk parameters related to continued airworthiness of aircraft and to analyze the factors that generally precede aircraft accidents.

R&D Partnerships: The U.S. Air Force Air Mobility Command provides technical support and assistance in developing safety critical performance measures. Discussions have been initiated with the Department of the Interior (DOI) regarding a partnership with DOI for sharing aviation safety data. An interagency agreement was established with the Department of Energy (DOE), enabling Sandia National Laboratories to contribute their technical expertise in developing system design, development, and safety, as well as safety performance measures, risk indicators, and the implementation of a data quality improvement strategy. The Air Carrier Operations System Model (FAR Part 121) will be developed with several major air carriers. HAI continues to work with the FAA to develop and enhance the Web-based MMIR system that now accepts data from helicopter on-board Health, Usage and Monitoring Systems (HUMS) for safety analysis and condition based maintenance monitoring. Several university grants have been awarded to support the development and testing of aviation safety risk models. For example, Rutgers University is contributing to the development of the Intelligent Decision Support Tool and the Aviation System Risk Model.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Risk Management Decision Support

- Initiated the design of flight standards next generation safety critical performance measures and risk indicators based on system engineering and system safety models of FAR Parts 121, 142, and 145. These tasks were accomplished in conjunction with industry.
- Continued development of new and enhanced risk analysis models and capabilities.
- Continued the development and incorporation of safety critical performance measures into flight standards (SPAS).
- Continued a decision support system requirements study.
- Continued workshops with industry to discuss aviation risk analysis and safety perfor-

mance measurement methodologies and tools.

- Continued to develop risk/hazard/accident models and tools based on FAR Parts 129, 142, and 145.
- Continued the development of the Aviation Safety Risk Management System.
- Released the Repair Station Prototype.
- Completed a repair station information requirements study and analysis.
- Continued development of systems engineering models based on FAR Parts 121,129,142, and 145.

Aircraft Maintenance - Maintainability and Reliability

- Established a demonstration network between a service station and a central server for downloading data from helicopters fitted with part tracking capabilities.
- Completed a handbook on Eligibility and Evaluation of U.S. Military Surplus Flight Safety Critical Aircraft Parts, Engines and Propellers.
- Initiated development of a web-based information system that facilitates the collection, analysis, dissemination and archive of aircraft maintenance related data such as MIS reports.
- Initiated research into establishing criteria for utilizing BITE.

Safety Analysis Methodology

- Continued the development of a methodology that will enable the Aircraft Certification Systems Evaluation Program (ACSEP) to focus on those areas statistically found to have the greatest impact on aviation safety.
- Continued the development of probabilistic safety assessment methodology that addresses aircraft systems safety analysis.

KEY FY 2002 PRODUCTS AND MILESTONES:

Risk Management Decision Support

- Continue to develop, test, and validate new and enhanced risk analysis models and capabilities.
- Complete the development of risk assessment indicators and safety critical performance measures using enhancements to the system engineering and system safety models based on Parts 121, 142, and 145 in conjunction with industry.
- Release the Repair Station Module.
- Initiate the development of a system engineering model based on FAR Part 135 operations.
- Continue workshops with industry to discuss aviation risk analysis and safety performance measurement models and methods.
- Continue the development of the Aviation Safety Risk Management System.
- Continue the design of decision support system options analysis.
- Continue the development of Risk/Hazard/Accident models and tools.

Aircraft Maintenance - Maintainability and Reliability

- Continue to enhance the Maintenance Malfunction Information Reporting System with the capability to collect helicopter flight hours and usage profiles.
- Completed the establishment of criteria for utilizing BITE as an approval for returning aircraft to service.
- Continue the development of a web-based information system that facilitates the collection, analysis, dissemination and archive of aircraft maintenance-related data such as MIS reports.
- Continue research to develop Advisory Circulars on eligibility and evaluation of U.S. Military FSCAP for other critical aircraft systems.

Safety Analysis Methodology

- Complete the development of a probabilistic safety assessment methodology that addresses aircraft systems safety analysis.
- Complete the ACSEP improvement of a methodology that incorporates inspection results into the policy development process.

FY 2002 PROGRAM REQUEST:

In FY 2002, research continues to focus on the areas listed at the beginning of the GOALS section above. Data assimilation, analysis, and tool development continue in support of ASRA initiatives. The analysts work with government, industry, and academia aviation safety subject matter experts. This cooperation will ensure that risk management/decision support tools, including safety critical performance measures and risk indicators are properly defined, developed, tested, and evaluated prior to implementation. The program investigates, tests, and recommends improvements, including standardization, to the quality (and quantity) of data used in the performance measures. It also completes studies to identify and verify flight standards and aircraft certification safety information requirements.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 23,836
FY 2001 Enacted	6,642
FY 2002 Request	5,784
Out-Year Planning Levels (FY 2003-2006)	24,392
Total	$ 60,654

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Aviation Safety Risk Analysis	5,289	5,555	5,286	5,150	4,377
Personnel Costs	1,039	794	1,393	1,414	1,253
Other In-house Costs	213	122	145	78	154
Total	**6,541**	**6,471**	**6,824**	**6,642**	**5,784**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	6,541	6,471	6,824	6,642	5,784
Development (includes prototypes	0	0	0	0	0
Total	**6,541**	**6,471**	**6,824**	**6,642**	**5,784**

A06g - Aviation Safety Risk Analysis Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
060-110 Aviation Safety Risk Analysis							
Risk Management Decision Support	$3,313						
Design Flight Standards Next Generation Safety Critical Performance Measures and Indicators Based on System Engineering and System Safety Models based on FAR Parts 129, 142, and 145.		◆	◇	◇	◇	◇	
Develop, Test, Validate and Enhance Risk Analysis Models and Capabilities		◆	◇	◇	◇	◇	
Develop and Implement Safety Critical Performance Measures		◆	◇	◇	◇	◇	◇
Conduct a Decision Support System Requirements Study		◆	◇	◇	◇	◇	◇
Conduct Workshops with Industry to Discuss Aviation Risk Analysis and Safety Performance Measurement Methodologies and Tools		◆	◇	◇	◇	◇	◇
Develop Risk/Hazard/Accident Models and Tools based on FAR Parts 129, 142, and 145.		◆	◇	◇	◇	◇	
Develop the Aviation Safety Risk Management System		◆	◇	◇			
Develop System Engineering Models Based on FAR Parts 129, 142, and 145. 121,		◆	◇				
Design the Decision Support System Options Analysis Model		◆	◇	◇	◇	◇	◇
Released the Air Personnel Module		◆					
Release Repair Station Prototype				◇			
Aircraft Maintenance: Maintainability & Reliability	$591						
Establish Criteria for Utilizing Built-in Test Equipment (BITE)		◆	◇				
Enhance the Maintenance Malfunction Information Reporting (MMIR) System		◆	◇	◇			
Complete Research Materials Necessary to Support the Development of Advisory Circulars on Eligibility and Evaluation of U.S. FSCAP for Other Critical Aircraft Systems		◆	◇	◇			
Develop Web-based Information System for Aircraft Maintenance		◆	◇	◇			
Safety Analysis Methodology	$473						
Develop and Integrate an ACSEP Improvement Methodology		◆	◇				
Develop Methodology for Probabilistic Safety Assessment of Aircraft Systems		◆	◇				
Personnel and Other In-House Costs	$1,407						
Total Budget Authority	$5,784	$6,642	$5,784	$5,908	$6,024	$6,172	$6,288

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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